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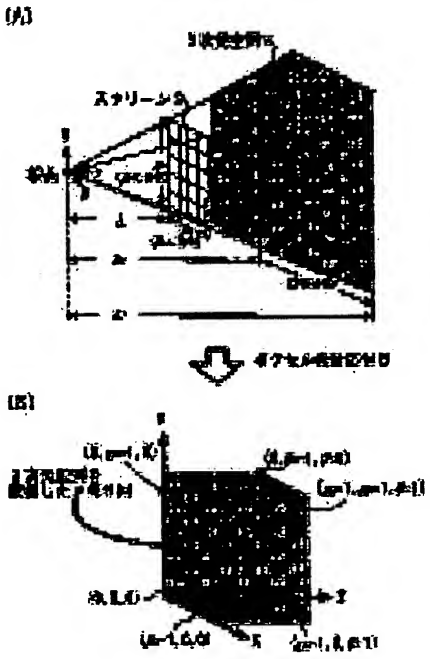
(54) METHOD AND DEVICE FOR PROCESSING IMAGE AND RECORDING MEDIUM RECORDING IMAGE PROCESSING PROGRAM

(57)Abstract:
PROBLEM TO BE SOLVED: To realize rendering by voxel division by which aliasing does not occur with a small amount of required memory capacity in an image processing using a rendering method such as rate racing.

SOLUTION: The three axes of a three-dimensional space V to be a display object are adopted as an X-axis, a Y-axis and a Z-axis with a viewpoint as an original point and a screen S or displaying is vertically positioned as against the Z-axis. When it is assumed, the three-dimensional space V is divided into D (a certain integer) in parallel with a screen plane. Besides, it is divided by a plane passing the view point and the boundary of a pixel on the screen S to generate truncated pyramids. The truncated pyramids are assigned to a three-dimensional arrayal memory M, the intersection point of a light beam from the viewpoint with an object is located on the memory M and intersection is judged.



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CLAIMS

[Claim(s)]

[Claim 1] In the image-processing approach using the rendering technique, such as ray tracing A view Three shafts of the three-dimension space V which considers as a zero and serves as an object for a display Suppose that there are the X-axis, a Y-axis, the Z-axis, and a screen S to display at right angles to the Z-axis of the three-dimension space V, divide the three-dimension space V into a screen flat surface at a certain integer D individual at parallel, and it divides further at the flat surface which passes along the boundary of the pixel of Screen S through a view. The image-processing approach characterized by generating rectangular-head frustum, assigning these rectangular-heads frustum to the memory M which defined the three dimensional array, respectively, searching the intersection of the beam of light from a view, and a body on the memory M, and performing a crossover judging.

[Claim 2] It sets to the image-processing approach according to claim 1, and is zl about zs and maximum in the minimum value of the Z-axis of the three-dimension space V. When carrying out and setting the integers from 1 to (D-1) to n, it is said three-dimension space V z=zs / (1-(1-zs /zl) /Dxn) of a degree type

The image-processing approach characterized by dividing at a ******** flat surface.

[Claim 3] Claim 1 Or one defined by the three-dimension camera system of coordinates which set [the die length of the X-axis of Screen S / the number of sw and pixels / the die length of pw and a Y-axis] distance with ph and a view to L for the number of sh and pixels, and serve as an object for a display in the image-processing approach according to claim 2 Or top-most vertices of multipolygon P () [xv, yv,] [zv] xm =pw /sw xLxxv /zvym =ph /sh xLxyv /zvzm =(1-zs /zv) /(1-zs /zl) xD (however, xm, ym, and zm are integer-ized) of a degree type is followed. A three dimensional array By changing into the coordinate (xm, ym, and zm) of the

defined memory M The drawing information on a polygon P is written in the periphery and inner surface of a polygon P in the system of coordinates of the memory M obtained. A memory coordinate (xC, yC, 0) for the drawing data of the coordinate (xC and yC) of 1 pixel c of the arbitration of Screen S the starting point and a direction vector (0, 0, 1) The image-processing approach characterized by searching the inside of room as a beam of light from a view, asking for the color data of a pixel in quest of an intersection with the polygon P for a display, calculating similarly to all the pixels in Screen S further, and generating a three-dimension image.

[Claim 4] It is the image processing system which generates the three-dimension image which consists of a memory write-in circuit, memory, and a ray-tracing circuit, and is displayed on a screen flat surface. Said memory write-in circuit Take the XYZ system of coordinates of the three-dimension space V for a display so that a screen flat surface may become vertical to the Z-axis, and divide the three-dimension space V at the flat surface of D individual (D is a certain integer) parallel to a screen flat surface, and it divides at the flat surface which passes along the boundary of the pixel of a view and a screen further. Rectangular-head frustum is generated and the drawing field calculation circuit which assigns these rectangular-heads frustum to said memory which defined the three dimensional array is included. Said ray-tracing circuit The image processing system characterized by including the crossover judging circuit which searches the intersection of the beam of light from a view, and the body for a display on said memory, and performs a crossover judging.

[Claim 5] Setting to an image processing system according to claim 4, said drawing field calculation circuit is zl about zs and maximum in the minimum value of the Z coordinate value of the three-dimension space V. When carrying out and setting the integers from 1 to D-1 to n, it is said three-dimension space V z=zs / (1-(1-zs /zl) /Dxn) of a degree type

The image processing system characterized by being what divided at the flat surface of a ******** D individual.

[Claim 6] A view is made into a zero in an image processing system according to claim 4 or 5. When taking the XYZ system of coordinates of said three-dimension space V and setting [the die length of the X-axis of a screen / the number of sw and pixels / the die length of pw and a Y-axis] distance with ph and a view to L for the number of sh and pixels, Said memory write-in circuit is a point in the three-dimension space V (xv, yv, and zv) xm =pw /sw xLxxv /zvym =ph /sh xLxyv /zvzm =(1-zs /zv) / () of a degree type [1-zs] The coordinate transformation circuit changed into the system of coordinates (xm, ym, and zm) of memory which defined the three dimensional array

according to /zl xD (however, xm, ym, and zm are integer-ized), One for a display Or based on the coordinate transformation result of the top-most vertices of multipolygon P, the drawing field calculation circuit which writes the drawing data of a polygon P in the periphery and inner surface of a polygon P in the system of coordinates of memory is included, and said ray-tracing circuit is 1 pixel () of the arbitration of a screen. [xC,] [yC] The optical-path arithmetic circuit which computes a memory coordinate (xC, yC, 0) for the receiving optical path as the starting point and a direction vector (0, 0, 1), The image processing system characterized by including the crossover judging circuit which searches the inside of memory according to the computed optical path, and computes an intersection with the polygon P for a display, the computed intersection, and the color data arithmetic circuit which computes the color data of said pixel from the drawing information on memory.

[Claim 7] The rendering technique, such as ray tracing The image processing to be used A program for a computer to perform It is the recorded record medium. A view Three shafts of the three-dimension space V which considers as a zero and serves as an object for a display Suppose that there are the X-axis, a Y-axis, the Z-axis, and a screen S to display at right angles to the Z-axis of the three-dimension space V, divide the three-dimension space V into parallel at a screen S flat surface at an integer D individual, and it divides further at the flat surface which passes along the boundary of the pixel of Screen S through a view. Generate rectangular-head frustum, assign these rectangular-heads frustum to the memory M which defined the three dimensional array, respectively, and the intersection of the beam of light from a view and a body is searched on the memory M. The record medium which recorded the image-processing program characterized by recording the program which makes a computer perform processing which performs a crossover judging.

[Claim 8] Setting to the record medium which recorded the image-processing program according to claim 7, said image-processing program is zl about zs and maximum in the minimum value of the Z-axis of the three-dimension space V. When carrying out and setting the integers from 1 to (D-1) to n, it is said three-dimension space V z=zs / (1-(1-zs /zl) /Dxn) of a degree type

The record medium which recorded the image-processing program characterized by including the program which makes a computer perform processing divided at a ******** flat surface.

[Claim 9] In the record medium which recorded the image-processing program according to claim 7 or 8 said image-processing program The die length of the X-axis

of Screen S The number of sw and pixels The die length of pw and a Y-axis The number of sh and pixels Distance with ph and a view The top-most vertices (xv, yv, and zv) of one or more polygons P defined by the three-dimension camera system of coordinates which set to L and serve as an object for a display xm =pw /sw xLxxv /zvym =ph /sh xLxyv /zvzm of a degree type = By changing into the coordinate (xm, ym, and zm) of the memory M which defined the three dimensional array according to 1-zs /zv /(1-zs /zl) xD (however, xm, ym, and zm being integer-ized) The drawing information on a polygon P is written in the periphery and inner surface of a polygon P in the system of coordinates of the memory M obtained. A memory coordinate (xC, yC, 0) for the drawing data of the coordinate (xC and yC) of 1 pixel c of the arbitration of Screen S the starting point and a direction vector (0, 0, 1) Search the inside of room as a beam of light from a view, ask for the color data of a pixel in quest of an intersection with the polygon P for a display, and all the pixels in Screen S are received further. The record medium which recorded the image-processing program characterized by including the program which makes a computer perform processing which calculates similarly and generates a three-dimension image.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used by the three-dimension drawing system, and relates to the intersection calculation technique of the rendering technique, such as ray tracing, and the image processing technique using the processing especially.
[0002]
[Description of the Prior Art] There is the ray tracing method as the rendering technique which creates a three-dimension image. Drawing 7 is drawing for explaining the ray-tracing technique. As shown in drawing 7 , the ray tracing method generates the beam of light which passes the pixel on a screen from a view, investigates the point which crosses to all bodies, and performs a rendering. By this technique, there is a problem that the count of a crossover judging of a body and a beam of light becomes huge, and the processing time becomes large. As the technique of mitigating this processing time, as shown in drawing 8 , there is the technique of dividing three-dimension space into a small cube (voxel), matching them with the room which defined the three dimensional array, and carrying out a crossover judging. If all bodies are written in the memory and room is searched along with a beam of light, the processing time which a crossover judging takes is mitigable.
[0003] However, by this conventional voxel subdivision technique, a beam of light does not necessarily pass along the core of the voxel, aliasing arises, and there is a problem on which image quality deteriorates. Drawing 9 is drawing for explaining the problem on which this image quality deteriorates, and is drawing showing the conventional voxel subdivision technique seen from YZ flat surface. Like drawing 9 , the beam of light 1 which passes along the core of the pixel of Screen S from a view intersects Voxel A, and performs a rendering by the data of Voxel A. However, the drawing data of Voxel

A and Voxel B are continuing actually, the actual drawing data of an intersection with a beam of light 1 are data between Voxel A and Voxel B, and the difference serves as distortion of an image. As the technique of avoiding this, there is the technique of also calculating a beam of light 2 and two or more beams of light of beam-of-light 3 grade, and performing a rendering, according to this, image quality improves, but there is a problem that the processing time becomes large.

[0004] Moreover, by the above-mentioned technique, the more it separates distantly from a view, the more the number of voxel of X shaft orientations and Y shaft orientations increases. For this reason, there are memory space which defines the three dimensional array needed, and a problem of becoming large.

[0005]

[Problem(s) to be Solved by the Invention] Although the ray-tracing technique using the voxel can stop the amount of data processing as mentioned above, the memory space which aliasing arises, and image quality deteriorates and is needed for processing is also large. The object of this invention has little memory space to need, and is to realize the rendering by the voxel subdivision method which aliasing does not produce.

[0006]

[Means for Solving the Problem] In the image processing for which this invention uses the rendering technique, such as ray tracing A view Three shafts of the three-dimension space V which considers as a zero and serves as an object for a display Suppose that there are the X-axis, a Y-axis, the Z-axis, and a screen S to display at right angles to the Z-axis of the three-dimension space V, divide the three-dimension space V into the integer D individual which is in parallel at a screen flat surface, and it divides further at the flat surface which passes along the boundary of the pixel of a screen through a view. It is the image-processing approach of generating rectangular-head frustum, assigning these rectangular-heads frustum to the memory M which defined the three dimensional array, respectively, searching the intersection of the beam of light from a view, and a body on the memory M, and performing a crossover judging.

[0007] In this invention, in the rendering technique, such as ray tracing, since the beam of light which passes along the core of the pixel of a screen from a view divides so that it may always pass through the core of the voxel, it judges the crossover with the polygon for a display, and a beam of light and draws, aliasing does not arise but an image with little distortion can be generated at a high speed. Moreover, since the number of voxel of the X-axis and Y shaft orientations is equal to the number of pixels

of a screen also in a location distant from a view, the memory space needed for processing can be stopped low.

[0008]

[Embodiment of the Invention] [Gestalt 1 of operation] The example of the image-processing approach indicated to drawing 1 at claim 1 is shown. In the image processing using the rendering technique, such as ray tracing, a view is made into a zero and suppose that there are the X-axis, a Y-axis, the Z-axis, and a screen S to display three shafts of the three-dimension space V used as the object for a display vertically to the Z-axis of the three-dimension space V.

[0009] As shown in drawing 1 (A), the three-dimension space V is divided into Screen S and parallel at a certain integer D individual, it divides further at the flat surface which passes along the boundary of the pixel of Screen S through a view, and rectangular-head frustum is generated. It assigns the memory M which defined the three dimensional array as shows those rectangular-head frustums to drawing 1 (B), respectively. And the memory M is used for the crossover judging with the beam of light from a view and the body in the three-dimension space V which are performed by processing of ray tracing etc. Since the body set as all the display objects in the three-dimension space V is developed on Memory M, if the inside of Memory M is searched along with a beam of light, the crossover judging with the body of the three-dimension space V can be performed at a high speed.

[0010] Moreover, the three-dimension space V is divided at the flat surface passing through the boundary between the pixels of a view and Screen S, and forms the voxel. Therefore, if three-dimension space V used as the object for a display is voxel-ized by this technique, the beam of light which passed along the core of the pixel of Screen S from the view passes along the core of the voxel.

[0011] Drawing 2 shows the example divided into the voxel by this voxel-ized technique seen from YZ flat surface. It turns out that the beam of light passing through the core of a screen passes along the core of the voxel so that clearly from drawing 2 . Thus, since a beam of light passes along the core of the voxel, aliasing is not produced even if it draws only for the information on the voxel which intersected the beam of light. Although the technique by the conventional voxel subdivision needed to be searched for two or more optical paths in order to obtain a quality image, according to this technique, a quality image can be obtained by retrieval of one optical path.

[0012] [Gestalt 2 of operation] The example of the image-processing approach which starts drawing 3 at claim 2 is shown. At this drawing 3 , it is zl about zs and maximum

in the minimum value of the Z-axis of the three-dimension space V. It is [0013], when it carries out and the integers from 1 to D-1 are set to n.

[Equation 1]

$$z=\frac{z_s}{1-(1-\frac{z_s}{z_l})\cdot\frac{n}{D}} \qquad (式1)$$

[0014] Signs that it saw from YZ flat surface when dividing at a ******** flat surface are shown.

[0015] Drawing 4 is drawing which looked at the voxel at the time of dividing Z shaft orientations into division into equal parts from YZ flat surface. this drawing 4 — like — zs from — zl When it divides into division into equal parts in the section at D individual and assigns Memory M, on Memory M, paths, such as the reflected light on the three-dimension space V, serve as a curve, and it becomes complicated optical-path calculating them. on the other hand, it is shown in drawing 3 — as (formula 1) -- when it divides at the flat surface to fulfill, the straight line on the three-dimension space V turns into a straight line also on the corresponding memory M.

[0016] Hereafter, it proves becoming a straight line using a formula.

[0017] When distance with ph and a view is set [the die length of the X-axis of Screen S / the number of sw and pixels / the die length of pw and a Y-axis] to L for the number of sh and pixels and one point v on the three-dimension space V (xv, yv, and zv) corresponds to one point m on Memory M (xm, ym, and zm), the following relation is realized in v and m.

[0018]

[Equation 2]

$$x_m=\frac{p_w}{s_w}\cdot\frac{L}{z_v}x_v,\ y_m=\frac{p_h}{s_h}\cdot\frac{L}{z_v}y_v,\ z_m=D\cdot\frac{1-\frac{z_s}{z_v}}{1-\frac{z_s}{z_l}} \qquad (式2)$$

[0019] Here, it is [0020] when [in the three-dimension space V] there are three v1 (xv1, yv1, zv1), v2 (xv2, yv2, zv2), and v3 (xv3, yv3, zv3) on a straight line.

[Equation 3]

$$\frac{x_{v3}-x_{v1}}{x_{v2}-x_{v1}}=\frac{y_{v3}-y_{v1}}{y_{v2}-y_{v1}}=\frac{z_{v3}-z_{v1}}{z_{v2}-z_{v1}} \qquad (式3)$$

[0021] **********. First, it is [0022] when it develops about the term of y and z.

[Equation 4]

$$y_{v3} \cdot z_{v2} - y_{v3} \cdot z_{v1} - y_{v2} \cdot z_{v3} + y_{v2} \cdot z_{v1} + y_{v1} \cdot z_{v3} - y_{v1} \cdot z_{v2} = 0 \quad (式4)$$

[0023] It becomes. It is [0024] when (a formula 2) is substituted for the term of yv1, yv2, and yv3 of (a formula 4).

[Equation 5]

$$\frac{s_w}{p_w \cdot l}\left(y_{m3}z_{v3}z_{v2} - y_{m3}z_{v3}z_{v1} - y_{m2}z_{v2}z_{v3} + y_{m2}z_{v2}z_{v1} + y_{m1}z_{v1}z_{v3} - y_{m1}z_{v1}z_{v2}\right) = 0$$

$$\frac{y_{m3}}{z_{v1}} - \frac{y_{m3}}{z_{v2}} - \frac{y_{m2}}{z_{v1}} + \frac{y_{m2}}{z_{v3}} + \frac{y_{m1}}{z_{v2}} - \frac{y_{m1}}{z_{v3}} = 0 \quad (式5)$$

[0025] It becomes. It is [0026] when (a formula 2) is substituted for the term of zv1, zv2, and zv3 of (a formula 5).

[Equation 6]

$$\frac{1}{z_s}(y_{m3}-y_{m3}-y_{m2}+y_{m2}+y_{m1}-y_{m1})$$

$$-\frac{1}{D\cdot z_s}\left(1-\frac{z_s}{z_l}\right)(y_{m3}z_{m2}-y_{m3}z_{m1}-y_{m2}z_{m3}+y_{m2}z_{m1}$$

$$+y_{m1}z_{m3}-y_{m1}z_{m2})=0$$

$$\frac{y_{m3}-y_{m1}}{y_{m2}-y_{m1}}=\frac{z_{m3}-z_{m1}}{z_{m2}-z_{m1}} \qquad (式6)$$

[0027] **********. Similarly, it is [0028] when it calculates about x and z of (a formula 3).

[Equation 7]

$$\frac{x_{m3}-x_{m1}}{x_{m2}-x_{m1}}=\frac{y_{m3}-y_{m1}}{y_{m2}-y_{m1}}=\frac{z_{m3}-z_{m1}}{z_{m2}-z_{m1}} \qquad (式7)$$

[0029] Even if it changes the straight line on ******** and the three-dimension space V into the coordinate on Memory M using (a formula 2), it turns out that a straight line is maintained.

[0030] Therefore, if this conversion technique is used, the crossover judging with the reflected light, the refracted light, etc. and a body can be performed using the straight line on Memory M, and it can judge at a high speed.

[0031] [Gestalt 3 of operation] Drawing 5 is a processing flow chart which realizes the rendering approach using the technique of voxel-izing concerning claim 3.

[0032] first, the top-most vertices of one or more polygons P defined by the three-dimension camera system of coordinates which perform geometry processing (it changes into camera system of coordinates) of the polygon P for a display (step S1), and serve as an object for a display -- previously -- having been shown (formula 2) -- it changes into the system of coordinates of Memory M which used and defined

the three dimensional array (step S2). The drawing information on a polygon P is written in the coordinate of the memory M which hits the periphery and inner surface of a polygon P which were expressed with the system of coordinates of Memory M (step S3). If the writing to the memory of all polygons is completed (step S4), drawing processing by ray tracing will be performed.

[0033] As initial setting of ray-tracing processing to each pixel on Screen S, the coordinate of 1 pixel c on Screen S is set to (xc and yc), and let a memory coordinate (xc, yc, 0) into the start point E of a beam of light, and let (0, 0, 1) be the direction vectors V of a beam of light (step S5). The colour information of Pixel c searches the inside of room based on the direction vector V of the beam of light from a view, and asks for an intersection with the polygon P for a display (steps S6-S7). And colour information is calculated based on the drawing information on the polygon P of the intersection, and the writing to a screen is performed (step S8). By the case, the reflected light, refracted light, etc. from the intersection are calculated, and it adds to the colour information of Pixel c (step S9- S12). To all the pixels in a screen, (step S13) and a three-dimension image are generable by calculating similarly until drawing of all screens is completed.

[0034] [Gestalt 4 of operation] Drawing 6 is drawing showing the example of a block configuration of the image processing system concerning claim 4. This equipment consists of three-dimensional-array memory 20 which defined the polygon information write-in circuit 10 and the three dimensional array, and a ray-tracing processing circuit 30.

[0035] The polygon information write-in circuit 10 consists of a coordinate transformation circuit 11 which changes the top-most-vertices information on polygonal into memory system of coordinates according to the above (formula 2), and a drawing field calculation circuit 12 which calculates the memory coordinate in the given polygon and is given to memory as the address, and writes the drawing information on polygonal in the three-dimensional-array memory 20. The coordinate transformation circuit 11 consists of arithmetic units, and can realize the drawing field calculation circuit 12 using the scan line technique etc.

[0036] After the writing to the three-dimensional-array memory 20 finishes, by the ray-tracing processing circuit 30, from the information on the three-dimensional-array memory 20, a three-dimension image is generated by the ray-tracing technique, and it writes in video memory 40. This ray-tracing processing circuit 30 generates the memory address which met the optical path by the optical-path arithmetic circuit 31, and judges whether a polygon is on a beam of light

in the crossover judging circuit 32. When it crosses, the color data written in video memory 40 by the color data arithmetic circuit 33 based on the drawing information on the three-dimensional-array memory 20 are calculated. Moreover, based on the data of the reflection factor of the intersection, or a refractive index, a beam-of-light vector is searched for by the reflected light and the refraction optical operation circuit 34, the optical-path arithmetic circuit 31 is given, and it asks for the color data of the reflected light or the refracted light similarly. In addition, these arithmetic circuits are realizable with the integrated circuit which combined the logical circuit.

[0037] Moreover, computers, such as general-purpose CPU and DSP (Digital Signal Processor), can also perform these processings. The program for performing these processings is storable in suitable record media, such as portable medium memory which a calculating machine can read, semiconductor memory, and a hard disk.

[0038]

[Effect of the Invention] Since the beam of light which passes along the core of the pixel of a screen from a view in the rendering technique, such as ray tracing, divides so that it may always pass through the core of the voxel, it judges the crossover with the polygon for a display, and a beam of light and draws by using this invention as stated above, aliasing does not arise but an image with little distortion can be generated at a high speed. Moreover, since the number of voxel of the X-axis and Y shaft orientations is equal to the number of pixels of a screen also in a location distant from a view, the memory space needed for processing can be stopped low.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing for explaining the gestalt of operation of the 1st of the image-processing approach.

[Drawing 2] It is drawing which was seen from YZ flat surface and in which showing the voxel-ized technique of the gestalt the 1st operation.

[Drawing 3] It is drawing for explaining the gestalt of operation of the 2nd of the image-processing approach.

[Drawing 4] It is drawing which looked at the voxel at the time of dividing Z shaft orientations into division into equal parts from YZ flat surface.

[Drawing 5] It is the processing flow chart which realizes the rendering approach using the voxel-ized technique of the gestalt the 3rd operation.

[Drawing 6] It is drawing showing the example of a block configuration of an image processing system.

[Drawing 7] It is the ray-tracing technique explanatory view.

[Drawing 8] It is drawing showing the conventional voxel subdivision technique.

[Drawing 9] It is drawing showing the conventional voxel subdivision technique seen from YZ flat surface.

[Description of Notations]

S Screen

V Three-dimension space

M Memory which defined the three dimensional array

L Distance of a view and a screen

D A certain integer

sw The die length of the X-axis of a screen

sh The die length of the Y-axis of a screen

pw The number of the pixels of X shaft orientations of a screen
ph The number of the pixels of Y shaft orientations of a screen
zs The minimum value of the Z-axis
zl Maximum of the Z-axis

[Translation done.]